or through a hole.

Splice - mechanical: a loop formed in the end of a rope and connected by pressing (swaging) one or more metal sleeves over the junction of the rope.

Splice - short: a splice using less material than a long splice but increasing the circumference.

Strand laid rope: a wire rope made with strands formed around a fiber core, wire core, or independent wire rope core.

Swaged fittings: fittings in which wire rope is inserted and attached by cold flowing method.

Wire rope: a number of strands laid helically about a metallic or non-metallic core. Each strand consists of a number of wires also laid helically about a metallic or non-metallic center. Wire rope is specified by the kind of core, the number of strands, the number, sizes, and arrangement of the wires in each strand, and the way in which the wires and strands are wound or laid about each other. Wire rope is commonly designated by two numbers: the first indicating the number of strands and the second the number of wires per strand (for ropes with a wire strand core, a second group of two numbers may be used to indicate the construction of the wire core).

Wire strand core: consists of a multiple-wire strand that may be the same as one of the strands of the rope: it is smoother and more solid than the independent wire rope core and provides a better support for the rope strands.

SECTION 16

MACHINERY AND MECHANIZED EQUIPMENT

16.A GENERAL

16.A.01 Before any machinery or mechanized equipment is placed in use, it shall be inspected and tested by a competent person and certified to be in safe operating condition.

a. Inspections and tests shall be in accordance with the manufacturer's recommendations and shall be documented.

b. Records of tests and inspections shall be maintained at the site by the contractor, and shall be made available upon request of the designated authority, and shall become part of the official project file.

16.A.02 Daily/shift inspections and tests.

a. All machinery and equipment shall be inspected daily (when in use) to ensure safe operating conditions: the employer shall designate competent persons to conduct the daily inspections and tests.

b. Tests shall be made at the beginning of each shift during which the equipment is to be used to determine that the brakes and operating systems are in proper working condition and that all required safety devices are in place and functional.

16.A.03 Whenever any machinery or equipment is found to be unsafe, or whenever a deficiency which affects the safe operation of equipment is observed, the equipment shall be immediately taken out of service and its use prohibited until unsafe conditions have been corrected.

a. A tag indicating that the equipment shall not be operated, and that the tag shall not be removed, shall be placed in a

conspicuous location on the equipment. Where required, lockout procedures shall be used. ***> See section 12***

b. The tag shall remain in its attached location until it is demonstrated to the individual deadlining the equipment that it is safe to operate.

c. When corrections are complete, the machinery or equipment shall be retested and reinspected before being returned to service.

16.A.04 Machinery and mechanized equipment shall be operated only by designated qualified personnel.

a. Machinery or equipment shall not be operated in a manner that will endanger persons or property nor shall the safe operating speeds or loads be exceeded.

b. Getting off or on any equipment while it is in motion is prohibited.

c. Machinery and equipment shall be operated in accordance with the manufacturer's instructions and recommendations.

d. The use of headphones for entertainment purposes (e.g., AM/FM radio or cassette) while operating equipment is prohibited.

16.A.05 When the manufacturer's instructions or recommendations are more stringent that the requirements of this manual, the manufacturer's instructions or recommendations shall apply.

16.A.06 Inspections or determinations of road conditions and structures shall be made in advance to assure that clearances and load capacities are safe for the passage or placing of any machinery or equipment.

16.A.07 Equipment requirements.

a. Seats or equal protection must be provided for each person required to ride on equipment.

b. Equipment operated on the highway shall be equipped with headlights, taillights, brake lights, and backup light and turn signals visible from the front and rear.

c. All equipment with windshields shall be equipped with powered wipers. Vehicles that operate under conditions that cause fogging or frosting of windshields shall be equipped with operable defogging or defrosting devices.

d. Mobile equipment, operating within an off-highway job site not open to public traffic, shall have a service brake system and a parking brake system capable of stopping and holding the equipment while fully loaded on the grade of operation. In addition, it is recommended that heavy duty hauling equipment have an emergency brake system which will automatically stop the equipment upon failure of the service brake system; this emergency brake system should be manually operable for the driver's position.

16.A.08 Maintenance and repairs.

a. Maintenance, including preventive maintenance, and repairs shall be in accordance with the manufacturer's recommendations and shall be documented. Records of maintenance and repairs conducted during the life of a contract shall be made available upon request of the designated authority.

b. All machinery or equipment shall be shut down and positive means taken to prevent its operation while repairs or manual lubrications are being done. Equipment designed to be serviced while running are exempt from this requirement.

c. All repairs on machinery or equipment shall be made at a location which will protect repair personnel from traffic.

d. Heavy machinery, equipment, or parts thereof which are suspended or held apart by slings, hoist, or jacks also shall be substantially blocked or cribbed before personnel are permitted to work underneath or between them.

16.A.09 Bulldozer and scraper blades, end-loader buckets, dump bodies, and similar equipment shall be either fully lowered or blocked when being repaired or when not in use. All controls shall be in a neutral position, with the engines stopped and brakes set, unless work being performed on the machine requires otherwise.

16.A.10 Stationary machinery and equipment shall be placed on a firm foundation and secured before being operated.

16.A.11 All mobile equipment and the areas in which they are operated shall be adequately illuminated while work is in progress.

16.A.12 Equipment powered by an internal combustion engine will not be operated in an enclosed area unless adequate ventilation is provided to ensure the equipment does not generate a hazardous atmosphere.

16.A.13 All vehicles which will be parked or moving slower than normal traffic on haul roads shall have a yellow flashing light or four-way flashers visible from all directions.

16.A.13 No one shall be permitted in the truck cab during loading operations except the driver and then only if the truck has a cab protector. ***> See also 18.B.16a***

16.A.14 Mechanized equipment shall be shut down before and during fueling operations. Closed systems, with automatic shut-off which will prevent spillage if connections are broken,

may be used to fuel diesel powered equipment left running.

16.A.15 Towing.

a. All towing devices used on any combination of equipment shall be structurally adequate for the weight drawn and securely mounted.

b. Persons shall not be permitted to get between a towing vehicle and the piece of towed equipment until both have been completely stopped with all brakes set and wheels chocked on both vehicle and equipment.

16.A.16 All machinery or equipment operating on rails, tracks, or trolleys (except railroad equipment) shall be provided with substantial track scrapers or track clearers - effective in both directions - on each wheel or set of wheels.

16.A.17 Parking.

a. Whenever equipment is parked the parking brake shall be set.

b. Equipment parked on an incline shall have the wheels chocked or track mechanisms blocked and the parking brake set.

c. All equipment left unattended at night, adjacent to a highway in normal use or adjacent to construction areas where work is in progress, shall have lights or reflectors, or barricades equipped with lights or reflectors, to identify the location of the equipment.

16.A.18 No modifications or additions which affect the capacity or safe operation of machinery or equipment shall be made without the manufacturer's written approval.

a. If such modifications or changes are made, the capacity, operation, and maintenance instruction plates, tags, or decals

shall be changed accordingly.

b. In no case shall the original safety factor of the equipment be reduced.

16.A.19 Steering or spinner knobs shall not be attached to the steering wheel unless the steering mechanism prevents road reactions from causing the steering handwheel to spin: when permitted, the steering knob shall be mounted within the periphery of the wheel.

16.A.20 Safeguards shall be provided to prevent machinery and equipment operating on floating plant from going into the water. ***> See also 16.F.06***

16.A.21 All industrial trucks shall meet the requirements of design, construction, stability, inspection, testing, maintenance, and operation, defined in ANSI/ASME B56.1, *Safety Standards for Low Lift and High Lift Trucks*.

16.A.22 Lift trucks, stackers, and similar equipment shall have the rated capacity posted on the vehicle so as to be clearly visible to the operator. When auxiliary removable counterweights are provided by the manufacturer, corresponding alternate rated capacities also shall be clearly shown on the vehicle. The ratings shall not be exceeded.

16.A.23 The controls of loaders, excavators, or similar equipment with folding booms or lift arms shall not be operated from a ground position unless so designed.

16.A.24 Personnel shall not work or pass under or ride in the buckets or booms of loaders in operation.

16.A.25 Tire service vehicles shall be operated so that the operator will be clear of tires and rims when hoisting operations are being performed. Tires large enough to require hoisting equipment will be secured from movement by continued support

of the hoisting equipment unless bolted to the vehicle hub or otherwise restrained. ***> Also see 16.B.06***

16.A.26 Each bulldozer, scraper, dragline, crane, motor grader, front-end loader, mechanical shovel, backhoe, and other similar equipment shall be equipped with at least one dry chemical or carbon-dioxide fire extinguisher with a minimum rating of 5-B:C.

16.A.27 Fill hatches on water haul vehicles shall be secured or the opening reduced to a maximum of 20 cm (8 in).

16.B GUARDING AND SAFETY DEVICES

16.B.01 Reserve signal (back-up) alarm.

a. All self-propelled construction and industrial equipment, whether moving alone or in combination, shall be equipped with a reverse signal alarm. ***> Equipment designed and operated so that the operator is always facing the direction of motion does not require a reverse signal alarm***

b. Reverse signal alarms shall be audible and sufficiently distinct to be heard under prevailing conditions.

c. Alarms shall operate automatically upon commencement of backward motion. Alarms may be continuous or intermittent (not to exceed 3-second intervals) and shall operate during the entire backward movement.

d. Reverse signal alarms shall be in addition to requirements for signalpersons.

16.B.02 A warning device or signalperson shall be provided where there is danger to persons from moving equipment, swinging loads, buckets, booms, etc.

16.B.03 Guarding.

a. All belts, gears, shafts, pulleys, sprockets, spindles, drums, flywheels, chains, or other reciprocating, rotating or moving parts of equipment shall be guarded when exposed to contact by persons or when they otherwise create a hazard.

b. All hot surfaces of equipment, including exhaust pipes or other lines, shall be guarded or insulated to prevent injury and fire.

c. All equipment having a charging skip shall be provided with guards on both sides and open end of the skip area to prevent persons from walking under the skip while it is elevated.

d. Platforms, footwalks, steps, handholds, guardrails, and toeboards shall be designed, constructed, and installed on machinery and equipment to provide safe footing and accessways.

e. Equipment shall be provided with suitable working surfaces of platforms, guard rails, and hand grabs when attendants or other employees are required to ride for operating purposes outside the operator's cab or compartment: platforms and steps shall be of nonskid material.

f. Substantial overhead protection shall be provided for the operators of fork lifts and similar material handling equipment.

16.B.04 Fuel tanks shall be located in a manner which will not allow spills or overflows to run onto engine, exhaust, or electrical equipment.

16.B.05 Exhaust or discharges from equipment shall be so directed that they do not endanger persons or obstruct the view of the operator.

16.B.06 A safety tire rack, cage, or equivalent protection shall be

provided and used when inflating, mounting, or dismounting tires installed on split rims, or rims equipped with locking rings of similar devices. ***> Also see 16.A.25***

16.B.07 No guard, safety appliance, or device shall be removed from machinery or equipment, or made ineffective except for making immediate repairs, lubrications, or adjustments, and then only after the power has been shut off. All guards and devices shall be replaced immediately after completion of repairs and adjustments and before power is turned on.

16.B.08 Seatbelts and anchorages meeting the requirements of 49 CFR 571 shall be installed and worn in all motor vehicles (installation and usage on buses in optional); two-piece seat belts and anchorages for construction equipment shall comply with applicable federal specifications or SAE J 386a.

16.B.09 All high rider industrial trucks shall be equipped with overhead guards which meet the structural requirements defined in paragraph 4.21 of ANSI/ASME B56.1, *Safety Standards for Low Lift and High Lift Trucks*.

16.B.10 Suitable protection against the elements, falling or flying objects, swinging loads, and similar hazards shall be provided for operators of all machinery or equipment; glass used in windshields or cabs shall be safety glass.

16.B.11 Falling object protective structures (FOPs).

a. All bulldozers, tractors, or similar equipment used in clearing operations shall be provided with guards, canopies, or grills to protect the operator from falling and flying objects as appropriate to the nature of the clearing operations.

b. FOPs for other construction, industrial, and grounds-keeping equipment will be furnished when the operator is exposed to falling object hazards.

c. FOPs will be certified by either the manufacturer or a licensed engineer as complying with the following applicable Society of Automotive Engineers (SAE) recommended practices:

(1) J 231 - *Minimum Performance Criteria for Falling Object Protective Structures (FOPS)*
(2) J 1043 - *Minimum Performance Criteria for Falling Object Protective Structure (FOPS) for Industrial Equipment*

16.B.12 Rollover protective structures (ROPS).

a. In addition to the requirements of 16.B.08 and 16.B.11, seat belts and ROPS shall be installed on:

(1) crawler and rubber-tire tractors including dozers, push and pull tractors, winch tractors, and mowers;
(2) off-the-highway self-propelled pneumatic-tire earth movers such as trucks, pans, scrapers, bottom dumps and end dumps;
(3) motor graders;
(4) water tank trucks having a tank height less than the cab; and
(5) other self-propelled construction equipment such as front-end loaders, backhoes, rollers, and compactors.

b. ROPS are not required on:

(1) trucks designed for hauling on public highways,
(2) crane-mounted dragline backhoes,
(3) sections of rollers and compactors of the tandem steel-wheeled and self-propelled pneumatic tired type that do not have an operator's station,
(4) self-propelled rubber-tired lawn and garden tractors and side boom pipelaying tractors operated solely on flat terrain (maximum 10º slope; 20º slope permitted when off-loading from a truck) not exposed to rollover hazards, and
(5) cranes, draglines, or equipment on which the operator's cab and boom rotate as a unit.

c. ROPS may be removed from certain types of equipment when the work cannot be performed with the ROPS in place and when ROPS removal is justified and delineated in an activity hazard analysis and accepted in writing by the designated authority.

d. The operating authority shall furnish proof from the manufacturer or certification from a licensed engineer that the ROPS complies with the following SAE standards, as applicable:

(1) J 167a - *Overhead Protection for Agricultural Tractors - Test Procedures and Performance Requirements*;
(2) J 104c - *Performance Criteria for Rollover Protective Structures (ROPS) for Construction, Earthmoving, Forestry, and Mining Machines*;
(3) J 1042 - *Operator Protection for Industrial Equipment*;
(4) J 1084a - *Operator Protective Structure Performance Criteria for certain Forestry Equipment*;
(5) J 1194 - *Roll-Over Protective Structures (ROPS) for Wheeled Agricultural Tractors*;

e. ROPS shall also be acceptable if they meet the criteria of any state which has a Department of Labor approved OSHA program or meet Water and Power Resources Service requirements.

f. The following information permanently affixed to the ROPS is acceptable in lieu of a written certification:

(1) manufacturers or fabricator's name and address,
(2) ROPS model number, if any, and
(3) machine make, model, or series number that the structure is designed to fit.

g. Field welding on ROPS shall be performed by welders who are certified by the contractor as qualified in accordance with American Welding Society Standards D1.1, Military

Standard MIL-STD 248, or the equivalent.

16.B.13 All points requiring lubrication during operation shall have fittings so located or guarded to be accessible without hazardous exposure.

16.B.14 All machinery or equipment and material hoists operating on rails, tracks, or trolleys shall have positive stops or limiting devices either on the equipment, rails, tracks, or trolleys to prevent overrunning safe limits.

16.B.15 Under the following circumstances, long-bed end-dump trailers used in off-road hauling should be equipped with a roll-over warning device: the device should have a continuous monitoring display at the operator station to give the operator a quick and easily-read indicator and audible warning of an unsafe condition.

a. the material being dumped is subject to being stuck or caught in the trailer rather than exiting the bed freely, and
b. the dump site cannot be maintained in a nominally level condition (lateral slope less than 1^{o} - 2^{o}.

16.C CRANES AND DERRICKS - GENERAL

16.C.01 Unless otherwise specified, the requirements of this Section (16.C) are applicable to all cranes of the types listed in Table 16-1.

16.C.02 Every crane shall have the following documents with them at all times they are to be operated:

a. A copy of the operating manual developed by the manufacturer for the specific make and model of the crane; a copy of the operating manual for any crane operator aids with which the crane is equipped.

b. The load rating chart for the crane, which shall include:

(1) the crane make and model, serial number, and year of manufacturer;
(2) load ratings for all crane operating configurations, including optional equipment;
(3) recommended reeving for the hoist line; and
(4) operating limits in windy or cold weather conditions.

c. The crane's log book which shall be used to record operating hours and all crane inspections, tests, maintenance and repair. The log shall be updated daily as the crane is used and shall be signed by the operator and supervisor: service mechanics shall sign the log after conducting maintenance or repairs on the crane.

16.C.03 Responsibilities in crane operations.

a. The operator shall not engage in any activity which will divert his/her attention while operating the crane.

b. The operator shall respond to signals from the person who is directing the lift or an appointed signal person: when a signal person is not used in the crane operation, the operator shall ensure he/she has full view of the load and the load travel paths at all times the load is rigged to the crane.

c. Each operator is responsible for those operations under his direct control, including those items under (d), below: whenever there is any doubt as to safety, the operator shall consult his supervisor before commencing the operation.

d. Before a lift, except before critical lifts when these shall be done by the lift supervisor, the rigger shall ensure that:

(1) the crane is level and, where necessary, blocked,
(2) the load is well secured and balanced in the sling or lifting device before it is lifted more than a few inches,
(3) the lift and swing path is clear of obstructions and adequate clearance is maintained from electrical sources, and

(4) all persons are clear of the swing radius of the counterweight.

e. When two or more cranes are used to lift one load, one designated person shall be responsible for the operation.

(1) The designated person shall analyze the operation and instruct all personnel involved in the proper positioning, rigging of the load, and the movements to be made.

(2) The designated person shall make such determinations as the necessity to reduce crane ratings, load position, boom location, ground support, and speed of movement, which are required to safely make the lift.

(3) The designated person shall ensure that all prescribed communication (including signaling) personnel and/or equipment are on hand and properly functioning, and that all personnel involved with the crane operation understand the communication systems and their responsibilities associated with communications.

16.C.04 Operator designation.

a. Cranes and derricks may only be operated by qualified operators. Only those operators qualified to operate a particular type of crane or derrick may operate that type of machinery: proof of qualification shall be in writing.

b. Each USACE Command with USACE employees designated as crane or derrick operators shall designate a qualified individual(s) (in-house or contract) to administer examinations and to qualify USACE - but not contractor - operators.

c. Contractor crane and derrick operators shall be designated as qualified by a source which qualifies crane and derrick operators (e.g., an independent testing and qualifying company,

a union, a governmental agency, a qualified consultant (can be an in-house resource).

16.C.05 Operator qualifications and training.

a. Proficiency qualifications.

(1) Each operator shall be instructed in and qualified for each type of crane or derrick he/she is to operate.

(2) Qualification shall be by written (or oral) and practical operating examination unless the operator is licensed by a state or city licensing agency for the particular type of crane or derrick. (Qualification for operation of a particular type of crane or derrick on a Corps project shall be valid for three years.)
> See Appendix G

(3) As a minimum, the qualifying examination procedures in Appendix G shall be followed. When the crane manufacturer recommends operator qualifying examination procedures, those procedures shall be in addition to the requirements of Appendix G.

b. Operators shall meet the physical qualifications listed in Appendix G: at the minimum, examinations are required annually.

c. USACE crane and derrick operators (not contractor) shall complete a crane operators course which covers general crane operation and safety and is at least 24 hours in length. Yearly thereafter, operators shall complete an 8 hour refresher course covering safe operation of the type of crane or derrick they operate.

16.C.06 Cranes and derricks shall be designed and constructed in accordance with the applicable standards listed in Table 16-1.
> This requirement is applicable to all cranes and derricks manufactured and installations constructed, one year after

the date of publication of the applicable standard

16.C.07 Cranes and derricks shall be operated, inspected, tested and maintained in accordance with the manufacturer's operating manual for the crane.

16.C.08 A hazard analysis shall be developed and implemented for crane set-up and set-down procedures (mobilization, assembly or erection, dismantling, and demobilization).

16.C.09 Clearances.

a. Adequate clearance shall be maintained from electrical sources. ***> See Section 11***

b. Adequate clearance shall be maintained between moving and rotating structures of the crane and fixed objects to allow the passage of employees without harm: the minimum adequate clearance is 40 cm (16 in).

TABLE 16-1

CRANE DESIGN AND CONSTRUCTION STANDARDS

Mobile and locomotive cranes - ASME/ANSI B30.5
Portal, tower, and pillar cranes - ASME/ANSI B30.4
Hammerhead tower cranes - ASME/ANSI B30.3
Floating cranes and floating derricks - ASME/ANSI B30.8
Draglines - Power Crane and Shovel Association Std #4
Articulating boom cranes - ASME/ANSI B30.22
Overhead and gantry cranes (top running bridge, single or multiple girder, top running trolley hoist) - ASME/ANSI B30.2
Overhead and gantry cranes (top running bridge, single girder, underhung hoist) - ASME/ANSI B30.17
Monorails and underhung cranes - ASME/ANSI B30.11
Derricks - ASME/ANSI B30.6
Helicopter cranes - ASME/ANSI B30.12

c. Accessible areas within the swing radius of the rear of the crane's rotating superstructure, either permanently or temporarily mounted, shall be barricaded to prevent an employee from being struck or crushed by the crane.

16.C.10 Hoisting ropes shall be installed in accordance with the equipment manufacturer's recommendations.

a. Except for overhead and gantry cranes, there shall be at least three full wraps (not layers) of cable on the drums of hoisting equipment at all times; overhead and gantry cranes shall have at least two full wraps of cable on the drums of hoisting equipment at all times.

b. The drum end of the rope shall be anchored to the drum by an arrangement specified by the crane or rope manufacturer.

16.C.11 Communications.

a. A standard signal system shall be used on all cranes and derricks. ***> See Section 8***

b. In situations where the operator cannot see the load, audio (radio) communications shall be used (note that this does not preclude the use of hand signals in addition to audio): in all other operations, audio communications should be used.

16.C.12 Inspection of cranes and derricks shall be in accordance with the manufacturer's recommendations. Inspections shall be conducted by a qualified person and shall cover, at the minimum, the items listed in Appendix H.

a. Before initial use all new and altered cranes shall be inspected by a qualified person to ensure compliance with the applicable standards listed in 16.C.05.

b. Before initial use on a Corps project, and periodically thereafter (one to twelve months or as recommended by the

manufacturer) a periodic inspection shall be conducted by a qualified person.

(1) A copy of the checklist used for the inspection shall be maintained at the project site.

(2) A Corps of Engineers' representative shall be notified at least 24 hours before the inspection in order that he or she may observe the inspection.

c. Start-up (pre-operational) inspections shall be conducted by the operator before every operation (shift) of the crane. If checklists are used for pre-operational inspections, a copy of the checklist shall be maintained at the project site; if checklists are not used, the operator shall indicate the successful completion of the inspection - in accordance with the manufacturer's recommendations - in the operator's log.

d. Cranes not in use on a regular basis shall be inspected in accordance with the following. ***> See Appendix H***

(1) A crane which has been idle for 30 days or more, but less than 180 days, shall be given an inspection, conforming to the requirements for frequent crane inspections and frequent wire rope inspections, by a qualified person before placed in service.

(2) A crane which has been idle more than 180 days shall be given a complete inspection, conforming to the requirements for frequent and periodic crane inspections and frequent and periodic wire rope inspections, by a qualified person before placed in service.

(3) Standby cranes shall be inspected by a qualified person at least semiannually and before placed in service. Inspection requirements depend on the length of time since the previous inspection, in accordance with paragraphs (1) and (2) above; standby cranes which are exposed to adverse environmental conditions shall be inspected more frequently, as determined by

the designated authority.

16.C.13 Performance tests. ***> See also paragraph 16.D.06a***

a. Performance tests shall be conducted, by a qualified person, in accordance with the manufacturer's recommendations; at the minimum, performance testing shall meet the requirements listed in Appendix H. Test loads shall not exceed 100% of the manufacturer's load rating capacity chart at the configuration of the test except for manufacturer testing of new cranes, which shall be conducted in accordance with the ASME B30 standard appropriate for the crane.

b. Written reports of the performance test, showing test procedures and confirming the adequacy of repairs or alterations, shall be maintained with the crane or derrick or at the on-site project office.

c. Under the following circumstances, cranes shall be given an operational performance test:

(1) before initial use of cranes in which a load bearing (excluding the rope) or load controlling part or component, brake, travel component, or clutch have been altered, replaced, or repaired,
(2) every time it is reconfigured or reassembled after disassembly, and
(3) every year.

> Under conditions (1) and (2), a selective operational performance test - testing only those components which have or may have been affected by the alteration, replacement, repair, reconfiguration, or reassembly - may be performed

d. Under the following circumstances, cranes shall be given a load performance test:

(1) before initial use of cranes in which load bearing (excluding

the rope) or load controlling part or component, brake, travel component, or clutch have been altered, replaced, or repaired,
(2) every time the crane is reconfigured or reassembled after disassembly, and
(3) every four years.

> Under conditions (1) and (2), a selective operational performance test - testing only those components which have or may have been affected by the alteration, replacement, repair, reconfiguration, or reassembly - may be performed. When the load performance test of a powerhouse Indoor overhead crane would pose unacceptable risk to generators, the District Commander may waive this requirement.

16.C.14 The manufacturer's specifications and limitations applicable to the operation of any crane or derrick shall be followed: at no time shall a crane or derrick be loaded in excess of the manufacturer's rating, except overhead and gantry cranes in accordance with ASME/ANSI B30.2 when overrated loads shall not exceed 110% of rated load. ***> See 16.C.18***

a. Where manufacturer's specifications are not available, the limitations assigned to the equipment shall be based on the determinations of a registered engineer competent in this field and such determinations will be documented and recorded.

b. Attachments used with cranes shall not exceed the capacity, rating, or scope recommended by the manufacturer.

16.C.15 Riding on loads, hooks, hammers, buckets, material hoists, or other hoisting equipment not meant for personnel handling is prohibited.

16.C.16 When practical and when their use does not create a hazard, tag lines shall be used to control loads.

16.C.17 Whenever a slack line condition occurs, before further operations the proper seating of the rope in the sheaves and on the drum shall be checked.

16.C.18 Critical lift plans. Before making a critical lift, a critical lift plan shall be prepared by the crane operator, lift supervisor, and rigger. The plan shall be documented and a copy provided to the designated authority: the plan shall be reviewed and signed by all personnel involved with the lift.
> Critical lift is defined on page 285

a. The plan shall specify the exact size and weight of the load to be lifted and all crane and rigging components which add to the weight. The manufacturer's maximum load limits for the entire range of the lift, as listed in the load charts, shall also be specified.

b. The plan shall specify the lift geometry and procedures, including the crane position, height of the lift, the load radius, and the boom length and angle, for the entire range of the lift.

c. The plan shall designate the crane operator, lift supervisor and rigger and state their qualifications.

d. The plan will include a rigging plan which shows the lift points and describes rigging procedures and hardware requirements.

e. The plan will describe the ground conditions, outrigger or crawler track requirements, and, if necessary, the design of mats, necessary to achieve a level, stable foundation of sufficient bearing capacity for the lift. For floating cranes or derricks, the plan shall describe the operating base (platform) condition and any potential list.

f. The plan will list environmental conditions under which lift operations are to be stopped.

g. The plan will specify coordination and communication

requirements for the lift operation.

h. For tandem or tailing crane lifts, the plan will specify the make and model of the cranes, the line, boom, and swing speeds, and requirements for an equalizer beam.

16.C.19 Environmental considerations.

a. Cranes shall not be operated when wind speeds at the top of the crane approach the maximum wind velocity recommendations of the manufacturer.

b. Operations undertaken during weather conditions that produce icing of the crane structure or reduced visibility should be performed at reduced functional speeds and with signaling means appropriate to the situation.

c. When conditions are such that lightning could occur, all crane operations shall cease.

d. For night operations, lighting shall be adequate to illuminate the working areas while not interfering with the operators vision.

16.C.20 Maintenance and repairs.

a. Maintenance and repairs shall be conducted in accordance with the manufacturer's procedures and precautions.

b. Replacement parts or repairs shall have at least the original design factor; replacement parts for load bearing and other critical parts shall be either obtained from or certified by the original equipment manufacturer (OEM).

16.D CRAWLER-, TRUCK-, WHEEL-, AND RINGER-MOUNTED CRANES

16.D.01 All lattice boom and hydraulic mobile cranes (except articulating boom cranes) shall be equipped with a boom angle

indicator and a load indicating device, or a load moment indicator (rated capacity indicator): calibration and testing of indicators will be performed in accordance with the manufacturer's recommendations. ***> When cranes are used in duty cycle operations they are exempt from the requirements for load indicating devices and load moment indicators***

16.D.02 All lattice boom and hydraulic mobile cranes shall be equipped with a means for the crane operator visually to determine the levelness of the crane.

16.D.03 On all lattice boom and hydraulic mobile cranes (except articulating boom cranes), drum rotation indicators shall be provided and located to afford sensing by the operator. ***> Equipment manufactured before 1990 is exempt from this requirement but retrofit is highly recommended***

16.D.04 All lattice boom and hydraulic mobile cranes (except articulating boom cranes) shall be equipped with a boom angle or radius indicator located within the operator's view.

16.D.05 Anti-two block (upper limit) devices. When required on a crane, anti-two blocking devices are required for all points of two-blocking.

a. Lattice boom cranes shall be equipped with an anti-two block device to stop the load hoisting function before the load block or load contacts the boom tip.

b. Lattice boom cranes which are used exclusively for duty cycle operations are exempt from anti-two block equipment requirements. When a lattice boom crane engaged in duty cycle work is required to make a non-duty cycle lift (for example, to lift a piece of equipment), it will be exempt from the anti-two block equipment requirements if the following procedures are implemented:

(1) an international orange colored warning device (warning flag,

warning tape, or warning ball) is properly secured to the hoist line at a distance of 2.4 m to 3 m (8 ft to 10 ft) above the rigging;
(2) the signalperson acts as a spotter to alert the crane operator with a "STOP" signal when the warning device approaches the boom tip and the crane operator ceases hoisting functions when alerted of this;
(3) while the non-duty cycle lift is underway, the signalperson shall not stand under the load, shall have no duties other than as a signalperson, and shall comply with the signaling requirements of this manual.

c. For older lattice boom cranes with manually-activated friction brakes, due to cost prohibitions anti-two block warning devices may be used in lieu of anti-two block prevention devices. Such exemptions shall be approved by either the USACE Command or HQUSACE Safety and Occupational Health Office.

d. Telescopic boom cranes shall be equipped with an anti-two block device to stop the load hoisting function before the load block or load contacts the boom tip and to prevent damage to the hoist rope or other machine components when extending the boom.

e. Telescopic boom cranes which are used exclusively for duty cycle operations shall be equipped with a two-blocking damage prevention feature or warning device to prevent damage to the hoist rope or other machine components when extending the boom.

Articulating boom cranes are exempt from requirements of 16.D.05a, 16.D.05c, and 16.D.05d

16.D.06 All mobile cranes with cable-supported booms shall be equipped with:

a. Boom stops which, at the angle specified by the crane manufacturer, limit the movement of that portion of the boom

below the point at which the boom stop acts on the boom.

(1) The boom stop manufacturer shall certify that the boom stop has been designed, manufactured, and functionally tested such that it will fulfill the requirement of SAE J220, *Crane Boom Stops*. (Pre 1971 cranes will essentially meet the requirements of SAE J220 except for paragraph 4.1.)

(2) A crane boom stop field test will be conducted to verify the proper setup of the boom stops and functioning of the boom hoist disengaging device. This test will be conducted before initiating the performance test required by paragraphs 16.C.13. Deficiencies noted shall be corrected before the performance test. ***> See Appendix I for test procedures***

b. All jibs shall have positive stops to prevent their movement of more than 5^{o} above the straight line of the jib and boom on conventional crane booms.

c. A properly functioning boom hoist disengaging device which shall automatically and completely disengage the boom hoisting power from the boom hoist drum when the boom has reached its highest rated angle. When power is thus disengaged, the boom hoist drum shall automatically be restrained from motion in the lowering direction under any rated condition.

16.D.07 The crane's foundation shall be evaluated for stability. The evaluation shall consider ground conditions, static and dynamic loads, and operating quadrants. Cribbing shall be provided in accordance with the manufacturer's recommendations.

16.D.08 Boom assembly and disassembly.

a. The manufacturer's boom assembly and disassembly procedures shall be followed. The manufacturer's boom assembly and disassembly procedures shall be reviewed by all members of the assembly/disassembly team before assembly

and disassembly.

b. When removing pins or bolts from a boom, workers shall stay out from under the boom.

16.D.09 Outriggers.

a. When the load to be handled and/or the operating radius require the use of outriggers, or anytime when outriggers are used, outriggers shall be fully extended and set to remove the machine weight from wheels (except locomotive cranes).

b. When outrigger floats are used they shall be securely attached to the outriggers.

c. Blocking under outriggers floats shall meet the following requirements:

(1) sufficient strength to prevent crushing, bending, or shear failure,
(2) such thickness, width, and length as to completely support the float, transmit the load to the supporting surface, and prevent shifting, toppling, or excessive settlement under load, and
(3) use of blocking only under the outer bearing surface of the extended outrigger beam floats.

16.D.10 Unless the manufacturer has specified an on-rubber rating, mobile cranes shall not pick or swing loads over the side of the crane unless the outriggers (if so equipped) are down and fully extended.

16.D.11 Unless recommended against by the manufacturer, crane booms shall be lowered to ground level or secured against displacement by wind loads or other outside forces when not in use: if the manufacturer recommends against this practice, the manufacturer's recommended practice shall be followed.

16.E PORTAL, TOWER, AND PILLAR CRANES

16.E.01 All load bearing foundations, supports, and rail tracks shall be constructed or installed in accordance with the crane manufacturer's recommendations and the applicable ANSI/ASME standard.

16.E.02 Cranes shall be erected in accordance with the crane manufacturer's recommendations and the applicable ANSI/ASME standard.

a. The manufacturer's written erection instructions and a list of the weights of each component to be erected shall be kept at the site.

b. Erection shall be performed under the supervision of a qualified person.

c. An activity hazard analysis shall be developed and implemented for the erection procedures. The analysis will include a plan which shows:

(1) the location of the crane and adjacent buildings or towers, overhead power and communication lines, underground utilities;
(2) foundation design and construction requirements, and
(3) when the tower is erected within a structure, the plan shall show clearances between the tower and the structure and bracing and wedging requirements

d. Wind velocity at the site at the time of erection shall be a consideration and may be a limiting factor that could require suspending the erection operation.

e. Before crane components are erected, they shall be visually inspected for damage. Damaged members shall not be erected.

16.E.03 After erection, and before placing the crane in service,

the following shall be tested in accordance with the manufacturer's recommended procedures and ANSI/ASME B30.3 or B30.4, as applicable.

a. crane supports;
b. brakes and clutches, limit and overload switches, and locking and safety devices; and
c. load hoisting and lowering, boom hoisting and lowering, and swing motion mechanisms and procedures.

16.E.04 A boom angle or radius indicator shall be provided within the operator's view.

16.E.05 Luffing jib cranes shall be equipped with jib stops of a shock absorbing type, a jib hoist limit switch, and a jib angle indicator visible to the operator.

16.E.06 Rail clamps, if used, shall have slack between the point of attachment to the rail and the end fastened to the crane: rail clamps shall not be used as a means of restraining tipping of a crane.

16.E.07 Raising (climbing or telescoping) hammerhead tower cranes.

a. The operator of a hammerhead tower crane shall be present during climbing or telescoping operations.

b. Hammerhead cranes shall not be climbed or telescoped when wind speeds at the top of the crane exceed 0.9 m/s (20 mph) or as recommended by the manufacturer.

c. Climbing operations shall not be commenced until all support provisions required at the new support level are in place and as specified by a qualified person.

16.E.08 Tower cranes shall weathervane when left unattended;

luffing jib cranes shall have the boom elevated to 15^{o} when left unattended.

16.F FLOATING CRANES AND FLOATING DERRICKS

16.F.01 Construction.

a. Floating cranes and floating derricks shall be constructed to meet all stresses imposed on members and components:

(1) under normal operating conditions when installed, and
(2) when handling loads not exceeding manufacturer's load ratings with recommended reeving.

b. Barges and pontoons shall be constructed to withstand imposed loads.

16.F.02 The load rating of a floating crane or floating derrick shall be the maximum working loads at various radii as determined by the manufacturer or qualified person considering list and trim for each installation.

a. The load rating is dependant upon the structural competence of the crane or derrick, rope strength, hoist capacity, structural attachment to the floating platform, and stability and freeboard of the floating platform.

b. When deck loads are to be carried while lifting, the situation shall be analyzed for modified ratings.

c. When mounted on barges or pontoons, the rated loads and radii of land cranes and derricks shall be modified as recommended by the manufacturer.

16.F.03 Stability - operating list or trim. Unless the crane or derrick manufacturer recommends a lesser value, the following

shall be the maximum allowable list or trim:

a. Cranes, designed for barge or pontoon mounting, rated at 22,700 kg (25 tons) capacity or less shall have a maximum allowable list or trim of 5°.

b. Cranes, designed for barge or pontoon mounting, rated at 22,770 kg (25 tons) capacity or more shall have a maximum allowable list or trim of 7°, although 5° is recommended.

c. Derricks, designed for barge or pontoon mounting, rated at any capacity shall have a maximum allowable list or trim of 10°.

d. Land cranes and derricks mounted on barges or pontoons shall have a maximum allowable list or trim of 5°.

16.F.04 Stability - design load conditions.

a. Cranes or derricks designed for barge of pontoon mounting shall be stable under the following conditions:

(1) rated load, 2.7 m/s (60 mph) wind, 0.6 m (2 ft) minimum freeboard;
(2) rated load plus 25%, 2.7 m/s (60 mph) wind, 0.3 m (1 ft) minimum freeboard;
(3) high boom, no load, 2.7 m/s (60 mph) wind, 0.6 m (2 ft) minimum freeboard;
(4) for backward stability of the boom - high boom, no load, full back list (least stable condition), 4 m/s (90 mph) wind.

b. Land cranes and derricks mounted on barges or pontoons:

(1) Barge- or pontoon-mounted land cranes require modified ratings due to increased loading from list, trim, wave action, and wind: this rating will be different for each size of pontoon or barge used. Therefore, the load rating of barge- or pontoon-mounted land cranes and derricks shall not exceed that recommended by the manufacturer for the particular barge

or pontoon under the expected environmental conditions.

(2) All deck surfaces of the pontoon or barge shall be above the water.

(3) The entire bottom area of the barge or pontoon shall be submerged.

(4) Provide tie-downs for derricks to transmit the loading to the barge or pontoon.

(5) Cranes shall be blocked and secured to prevent shifting.

16.F.05 Environmental considerations.

a. The project supervisor shall obtain daily weather forecasts before beginning work and as frequently thereafter as required to monitor any potential weather problems. ***> See Section 19.A***

b. When a local weather storm warning exists, consideration shall be given to the recommendations of the manufacturer for securing the crane.

c. Work shall be halted when significant wave action exists.

16.F.06 Truck and crawler cranes shall be attached to the barge or pontoon by means of a slack tie-down system to tether the machines' travel: when stability of the barge or pontoon is not a factor and control barriers are provided, limited travel, as specified in an activity hazard analysis, may be authorized by the designated authority.

16.F.07 When loads approach the maximum rating of the crane or derrick, the person responsible for the job shall ascertain that the weight of the load has been determined within +/- 10% before it is lifted.

16.F.08 When operating in windy conditions or rough seas, the

rated load shall be reduced to allow for the wind and wave effect on the lifted load. ***> See also 16.C.18***

16.G OVERHEAD AND GANTRY CRANES

16.G.01 All load bearing foundations, anchorages, runways, and rail tracks shall be constructed or installed in accordance with the crane manufacturer's recommendations and ANSI/ASME B30.2 or B30.17, as applicable.

16.G.02 The rated load of the crane shall be plainly marked on each side of the crane.

a. If the crane has more than one hoisting unit, each hoist shall have its rated load marked on it or its load block.

b. Markings on the bridge, trolley, and load block shall be legible from the ground or floor.

16.G.03 Clearance shall be maintained between the crane, any structure or object, and any parallel running cranes and cranes operating at different elevations.

16.G.04 Contacts with runway stops or other cranes shall be made with extreme caution: the operator shall do so with particular care for the safety of persons on or below the crane, and only after making certain that any persons on the other cranes are aware of what is being done.

16.G.05 Operators of outdoor cranes shall secure them when leaving.

16.G.06 When the wind-indicating alarm of a cab-operated outdoor crane sounds, crane operations shall be discontinued and the crane shall be prepared and stored for excessive wind conditions.

16.H MONORAILS AND UNDERHUNG CRANES

16.H.01 Crane runways, monorail tracks, track supports, and track control devices shall be constructed or installed in accordance with the crane manufacturer's recommendations and ANSI/ASME B30.11.

16.H.02 The rated load of the crane shall be plainly marked on each side of the crane.

a. If the crane has more than one hoisting unit, each hoist shall have its rated load marked on it or its load block.

b. Markings on the bridge, trolley, and load block shall be legible from the ground or floor.

16.I DERRICKS

16.I.01 For permanent fixed locations, the owner shall provide the following load anchoring data (for nonpermanent installations, this data shall be determined by a qualified person):

a. Guy derricks.

(1) maximum horizontal and vertical forces when handling rated loads with the particular guy slope and spacing stipulated for the application, and
(2) maximum horizontal and vertical forces at the guys when handling rated loads with the particular guy slope and spacing stipulated for the application.

b. Stiffleg derricks.

(1) maximum horizontal and vertical forces at the mast base when handling rated loads with the particular stiffleg slope and spacing stipulated for the application, and
(2) maximum horizontal and vertical forces at the stifflegs when handling rated loads with the particular stiffleg arrangement

stipulated for the application.

16.I.02 Derrick booms, load hoists, and swinger mechanisms shall be suitable for the derrick work intended and shall be anchored to prevent displacement from imposed loads.

16.I.03 When rotating a derrick, sudden starts and stops shall be avoided and rotational speed shall be such that the load does not swing out beyond the radius at which it can be controlled: a tagline shall be used.

16.I.04 Boom and hoisting rope systems shall not be twisted.

16.I.05 Ropes shall not be handled on a winch head without the knowledge of the operator: when a winch head is being used, the operator shall be within reach of the power unit controls.

16.I.06 When securing the boom, dogs or other positive holding mechanisms on the hoist shall be engaged.

16.I.07 When not in use the derrick boom shall be either:

a. laid down,
b. secured to a stationary member as nearly under the head as possible by attachment of a sling to the load block;
c. lifted to a vertical position and secured to the mast (for guy derricks), or
d. secured against a stiffleg (for stiffleg derricks).

16.J HELICOPTER CRANES

16.J.01 Helicopter cranes shall comply with regulations of the Federal Aviation Administration.

16.J.02 Before each day's operation, a briefing shall be conducted to set forth the plan of operation for the pilot and ground personnel.

16.J.03 Loads shall be properly slung.

a. Tag lines shall be of a length that will not permit their being drawn up into rotors.

b. Pressed sleeve, swedged eyes, or equivalent means shall be used for all freely suspended loads to prevent hand splices from spinning open or cable clamps from loosening.

16.J.04 All electrically operated cargo hooks shall have the electrical activating device so designed and installed as to prevent inadvertent operation.

a. In addition, these cargo hooks shall be equipped with an emergency mechanical control for releasing the load.

b. The hooks shall be tested prior to each day's operation to determine that the release functions properly, both electrically and mechanically.

16.J.05 PPE equipment for employees receiving the load shall consist of eye protection and hard hats secured by chinstraps.

16.J.06 Loose-fitting clothing likely to flap in the downwash, and thus be snagged on hoist line, shall not be worn.

16.J.07 Every practical precaution shall be taken to provide for the protection of the employees from flying objects in the rotor downwash: all loose gear within 30 m (100 ft) of the place of lifting or depositing the load, and all other areas susceptible to rotor downwash shall be secured or removed.

16.J.08 The helicopter pilot shall be responsible for size, weight, and manner in which loads are connected to the helicopter: if, for any reason, the helicopter pilot believes the lift cannot be made safely, the lift shall not be made.

16.J.09 When employees are required to work under hovering

craft, safe access shall be provided for employees to reach the hoist line hook and engage or disengage cargo slings: employees shall not work under hovering craft except to hook, unhook, or position loads.

16.J.10 Static charge on the suspended load shall be dissipated with a grounding device before ground personnel touch the suspended load, or protective rubber gloves shall be worn by all ground personnel touching the suspended load.

16.J.11 The weight of an external load shall not exceed the rated capacity.

16.J.12 Hoist wires or other gear, except for pulling lines or conductors that are allowed to "pay out" from a container or roll off a reel, shall not be attached to any fixed ground structure or allowed to foul on any fixed structures.

16.J.13 When visibility is reduced by dust or other conditions, ground personnel shall exercise special caution to keep clear of main and stabilizing rotors: precautions shall also be taken to eliminate reduced visibility.

16.J.14 No unauthorized person shall be allowed to approach within 15 m (50 ft) of the helicopter when the rotor blades are turning.

16.J.15 Whenever approaching or leaving a helicopter with blades rotating, all employees shall remain in full view of the pilot and keep in a crouched position: employees shall avoid the area from the cockpit or cabin rearward unless authorized by the helicopter pilot to work there.

16.J.16 There shall be constant reliable communication between the pilot and a designated employee of the ground crew who acts as a signalperson during loading and unloading. This signalperson shall be distinctly recognizable from other ground personnel. ***> See Figure 8-9***

16.J.17 Good housekeeping shall be maintained in all helicopter loading and unloading areas.

16.K MATERIAL HOISTS

16.K.01 Material hoists shall be designed and constructed or installed in accordance with the requirements of ANSI A10.5.

16.K.02 Material hoist towers, masts, guys or braces, counterweights, drive machinery supports, sheave supports, platforms, supporting structures, and accessories shall be designed by a licensed engineer.

16.K.03 Hoist towers shall be erected and dismantled only under the direct supervision of a qualified individual.

16.K.04 A copy of the hoist operating manual shall be available at all times it is operated.

16.K.05 Material hoists and hoist tower systems shall be inspected in accordance with the manufacturer's recommendations.

a. Prior to initial use and each time after the tower is extended, all parts of the tower or mast, cage, bucket, boom, platform, hoisting machine, guys, and other equipment shall be inspected by a qualified person to ensure compliance with the manufacturer's inspection guidelines and ANSI A10.5.

b. Prior to initial use on a USACE project, and periodically thereafter (one to twelve months or as recommended by the manufacturer) a periodic inspection shall be conducted by a qualified person. Periodic inspections shall cover those items specified by the manufacturer: at the minimum, periodic inspections shall cover all sheaves, racks and pinions, guy ties, bolt connections, miscellaneous clamps, braces, and similar parts.

c. A USACE representative shall be notified at least 24 hours prior to any of the above inspections and may wish to accompany the contractor's inspector.

d. Pre-operational inspections (start-up procedures) shall be conducted by the operator prior to every operation (shift) of the hoist.

16.K.06 Before a hoist is placed in service and every 4 months thereafter, a car-arresting-device test shall be performed.

a. For rope-supported cars, the test shall be conducted in the following manner:

(1) pull a loop in the lifting rope and attach the test rope to each side of the loop above the bucket or platform,
(2) raise the platform or bucket to allow the load to be supported by the test rope,
(3) cut the test rope to allow the load to fall and activate the car-arresting device.

b. For car suspension other than rope supported, the test shall be conducted by creating an overspeed condition of the car.

c. Structural components shall be inspected for damage after the test and before the hoist is placed in operation again.

16.K.07 Maintenance and repairs.

a. Replacement parts for load bearing or critical components shall be either obtained from or certified by the equipment manufacturer.

b. Maintenance and repairs shall be conducted in accordance with the manufacturer's precautions and procedures.

16.K.08 Landings and runways.

a. Landing platforms and runways that connect the hoistway or tower to a structure shall be designed and constructed to sustain the maximum intended load without failure.

b. Floors or platforms which may become slippery shall have slip-resistant surfaces.

c. When workers may be exposed to falling objects, overhead protection, composed of 5 cm (2 in) planking or the equivalent, shall be provided.

d. A barricade shall be provided at the open ends of each landing: the barricade shall extend from the floor a distance of at least 0.9 m (36 in) and shall be of #19 US gage wire or the equivalent, with openings not exceeding 1.3 cm (0.5 in).

e. Material shall not be stored on landing platforms or runways.

16.K.09 Whenever a slack line condition occurs, prior to further operations the proper seating of the rope in the sheaves and on the drum shall be checked.

16.K.10 Hoisting ropes shall be installed in accordance with the equipment manufacturer's recommendations.

a. There shall be at least three full wraps of cable on the drums of hoisting equipment at all times.

b. The drum end of the rope shall be anchored to the drum by an arrangement specified by the crane or rope manufacturer.

16.K.11 Riding on material hoists or other hoisting equipment not meant for personnel handling is prohibited.

16.K.12 While hoisting equipment is in operation, the operator shall not perform any other work and shall not leave his/her

position at the controls until the load has been safely landed or returned to ground level.

16.K.13 Not more than one cage or bucket shall be operated at the same time by any one hoisting machine or operator.

16.K.14 Operating rules shall be established and posted at the operator's station of the hoist: such rules shall include signal system and allowable line speed for various loads. Rules and notices shall be posted on the car frame or crosshead in a conspicuous location, including the statement **"NO RIDERS ALLOWED."**

16.K.15 Air powered hoists shall be connected to an air supply of sufficient capacity and pressure to safely operate the hoist: pneumatic hoses shall be secured by some positive means to prevent accidental disconnection.

16.L PILEDRIVERS

16.L.01 Guys, outriggers, thrustouts, counter-balances, or rail clamps shall be provided to maintain stability of piledriver rigs.

16.L.02 Piledriver leads.

a. Swinging (hanging) leads.

(1) Swinging (hanging) leads shall have fixed ladders.

(2) Employees shall be prohibited from remaining on leads or ladders while pile is being driven.

b. Fixed leads.

(1) Fixed piledriver leads shall be provided with decked landings having guard rails, intermediate rails, and toeboards. Fixed ladders or stairs shall be provided for access to landings and head blocks.

(2) Fixed leads shall be provided with rings or attachment points so that workers exposed to falls of 1.8 m (6 ft) or greater may attach their safety belt lanyard to the leads.

c. Landings or leads shall not be used for storage of any kind.

d. Piledriver leads shall have stop blocks to prevent the hammer from being raised against the head block.

e. A blocking device, capable of supporting the weight of the hammer, shall be provided for placement in the leads under the hammer at all times while employees are working under the hammer.

f. Leads shall be free of projections or snags to minimize line damage and personnel safety hazards.

16.L.03 Dogs, on piledriver hoist drums, which automatically disengage when the load is relieved or the drum rotated shall be prohibited.

16.L.04 Guards shall be provided across the top of the head block to prevent cable from jumping out of the sheaves.

16.L.05 All hose connections to piledriver hammers, pile ejectors, or jet pipes shall be securely attached with an adequate length of at least 0.6 cm (1/4 in) alloy steel chain, having 1,500 kg (3,250 lbs) working load limit, or equal strength cable, to prevent whipping if the joint is broken.

16.L.06 Steam line controls shall consist of two shutoff valves, one of which shall be a quick-acting lever type within easy reach of the hammer operator.

16.L.07 Floating piledrivers.

a. The width of hulls of floating piledrivers shall not be less than 45% of the height of the lead above the water.

b. The operating deck of floating piledrivers shall be so guarded as to prevent piles which are being hoisted into driving position from swinging in over the deck.

16.L.08 Hoisting and moving pile.

a. All employees shall be kept clear when piling is being hoisted into the leads.

b. Hoisting of steel piling shall be done by use of a closed shackle or other positive attachment that will prevent accidental disengagement.

c. Taglines shall be used for controlling unguided piles and free-hanging (flying) hammers.

d. Hammers shall be lowered to the bottom of the leads while the piledriver is being moved.

16.L.09 When driving jacked piles, all access pits shall be provided with ladders and bulkheaded curbs to prevent material from falling into the pit.

16.L.10 When it is necessary to cut off the tops of driven piles, piledriving operations shall be suspended except where the cutting operations are located at least twice the length of the longest pile from the driver.

16.L.11 Pile extraction.

a. If piling cannot be pulled without exceeding the load rating of equipment, a pile extractor shall be used.

b. When pulling piling, crane booms shall not be raised more than 60^{o} above the horizontal.

c. Piling shall not be pulled by tipping the crane, releasing the load brake momentarily, and catching the load before the crane

has settled.

16.M DRILLING EQUIPMENT

16.M.01 Applicability: the requirements of this Section (16.M) are applicable to rock, soil, and concrete drilling operations.

16.M.02 Earth drilling equipment shall be operated, inspected, and maintained as specified in the manufacturer's operating manual: a copy of the manual will be available at the job site.

16.M.03 Prior to bringing earth drilling equipment on the job site, a survey shall be conducted to identify overhead electrical hazards and potential ground hazards, such as contact with unexploded ordnance, hazardous agents in the soil, or underground utilities.

a. The location of any overhead or ground hazards shall be identified on a site layout plan.

b. The findings of this survey and the controls for all potential hazards shall become a part of the hazard analysis for the activity.

16.M.03 The hazard analysis for an earth drilling activity will not be accepted unless:

a. it contains a copy of the MSDS for the drilling fluids, if required;
b. it meets the requirements of 01.A.09; and
c. it indicates that the site layout plan specified in 16.M.02 will become a part of the analysis, and will be covered at the preparatory inspection (pre-activity safety briefing), when the plan has been completed.

16.M.04 Training.

a. All members of drilling crews shall be trained in:

(1) the operation, inspection, and maintenance of the equipment,
(2) the safety features and procedures to be used during operation, inspection, and maintenance of the equipment, and
(3) overhead electrical line and underground hazards.

b. This training will be based on the equipment operating manual and the hazard analysis for the activity.

16.M.05 Earth drilling equipment shall be equipped with two easily-accessible emergency shutdown devices, one for the operator and one for the helper.

16.M.06 Clearance from electrical sources shall be as specified in 11.E.05.

a. Drilling equipment shall be posted with signs warning the operator of electrical hazards.

b. The equipment operator shall ascertain proper clearance before moving equipment. Clearance shall be monitored by a spotter or by an electrical proximity warning device.

16.M.07 Moving equipment.

a. Before earth drilling equipment is moved the travel route shall be surveyed for overhead and terrain hazards, particularly overhead electrical hazards.

b. Earth drilling equipment shall not be transported with the mast up. The exception is movement of the equipment required in drilling a series of holes, such as in blasting, if the following conditions are satisfied:

(1) movement is over level, smooth terrain;
(2) the path of travel has been inspected for stability and the absence of holes, other ground hazards, and electrical hazards; and

(3) the travel distance is limited to short, safe distances.

16.M.08 Equipment set-up.

a. Equipment shall be set-up on stable ground and maintained level: cribbing shall be used when necessary.

b. Outriggers shall be extended per the manufacturer's specifications.

c. When drilling equipment is operated in areas with the potential for classification as a confined space, the requirements of Section 6.1 shall be followed.

16.M.09 Equipment operation.

a. Weather conditions shall be monitored: operations shall cease during electrical storms or when electrical storms are imminent.

b. Drill crew members shall not wear loose clothing, jewelry, or equipment which might become caught in moving machinery.

c. Auger guides shall be used on hard surfaces.

d. The operator shall verbally alert employees and visually ensure employees are clear from dangerous parts of equipment before starting or engaging equipment.

e. The discharge of drilling fluids shall be channeled away from the work area to prevent the ponding of water.

f. Hoists shall be used only for their designed intent and shall not be loaded beyond their rated capacity. Steps shall be taken to prevent two-blocking of hoists.

g. The equipment manufacturer's procedures shall be followed if rope becomes caught in, or objects pulled into, a cathead.

h. Drill rods shall be neither run nor be rotated through rod slipping devices: no more than 0.3 m (1 ft) of drill rod column shall be hoisted above the top of the drill mast. Drill rod tool joints shall not be made up, tightened, or loosened while the rod column is supported by a rod slipping device.

I. Dust shall be controlled. When there is potential for silica exposure, the requirements contained in Appendix C shall be implemented.

j. Augers shall be cleaned only when the rotating mechanism is in neutral and the auger stopped: long-handled shovels shall be used to move cutting from the auger.

k. Open boreholes shall be capped and flagged; open excavations shall be barricaded.

l. Means (e.g., guard around the auger; barricade around the perimeter of the auger; electronic brake activated by a presence-sensing device) shall be provided to guard against employee contact with the auger.

m. The use of side-feed swivels collars on drill rods are restricted to those collars which are retained by either a manufacturer-design stabilizer or a stabilizer approved by a professional engineer.

DEFINITIONS

Altered: any change to the original manufacturer's design configuration. These are (1) replacement of weight-handling equipment parts and components with parts or components not identical with the original (i.e., change in material, dimensions, or design configuration); (2) the addition of parts or components not previously a part of the equipment; (3) the removal of components which were previously a part of the load handling equipment; and (4) rearrangement of original parts or components.

Anti-two block (upper limit) device: a device which is activated by two-blocking and disengages the particular function whose movement is causing the two-blocking.

Articulating boom crane: a crane consisting of a mainframe or base, rotating mast, boom, and one or more operator's stations. The crane can be stationary or mounted on a vehicle, track, locomotive, etc., and is used to lift, swing, and lower loads.

Boom stop: a device used to limit the angle of the boom at the highest recommended position.

Bridge: that part of a gantry or overhead crane which carries the trolley(s).

Cathead: a spool shaped attachment on a winch around which rope is wound for hoisting and pulling.

Crane operator aids: devices which are used to assist a crane operator in the safe operation of the crane, including: two-block warning devices, two-block prevention devices, load and load moment indicator devices, boom angle and radius indicators, boom and jib stops, boom hoist disengaging devices, limit switches, drum rotation indicators, etc.

Cribbing: a system of timbers, arranged in a rectangular pattern, used to support and distribute the weight of equipment.

Critical lift: a non-routine crane lift required detail planning and additional or unusual safety precautions. Critical lifts include lifts made when the load weight is 75% of the rated capacity of the crane; lifts which require the load will be lifted, swung, or placed out of the operator's view; of lifts made with more than one crane; lifts involving non-routine or technically difficult rigging arrangement; hoisting personnel with a crane or derrick; or any lift which the lift or crane operator believe should be considered critical.

Derrick: a lifting device consisting of a mast secured at the top by guys or braces and, with or without a boom, used with a hoisting mechanism and rigging.

Dragline: a bucket attachment for a crane which excavates by the crane drawing, with a cable, the bucket towards itself.

Drilling fluid (mud): fluid which is pumped into a drilled hole and used to wash cuttings from the hole: drilling mud is a type of drilling fluid made of a slurry of clay and water and which is used to coat and support the sides of the drill hole and seal off permeable strata.

Duty cycle: operations involving repetitive pick and swing, such as with a dragline, grapple, or clamshell: such operations are conducted primarily for production as opposed to placement.

Fixed lead: pile driving leads which are rigidly attached to a boom by horizontal struts extending from the leads to extended boom foot pins, thus providing a fixed triangular frame of boom, struts, and leads.

Gantry crane: a crane similar to an overhead crane except that the bridge is rigidly supported on two or more legs running on fixed rails or other runway.

Guy derrick: a fixed derrick consisting of a vertical mast capable of being rotated 360 (but not continuous rotation) supported by guys, and a boom which is pivoted at the bottom and capable of moving in a vertical plane; a reeved rope between the head (top) of the mast and the boom harness (at the boom point) allows lifting and lowering of the boom and a reeved rope from the boom point allows lifting and lowering of the load.

Hammerhead tower crane: a lifting machine arranged with a tower (mast), an upperstructure that rotates, a horizontally-extended load jib (boom) with trolley, and a counterweight jib extending in the direction opposite of the load jib:

neither jib are arranged for luffing. The trolley on the load jib traverses the length of the jib and contains the sheaves and accessory parts which make up the upper load block; the lower load block is suspended from the trolley.

Jib: on hammerhead cranes, the horizontal structural member attached to the rotating superstructure of a crane and upon which the load trolley travels; on mobile cranes, an extension attached to the boom to provide added boom length for lifting specified loads.

Lead: the device on a pile driver which maintains the hammer in position during the driving. A lead typically is made up to two vertical rails or guides, held together by a frame, in which the hammer moves vertically.

Lift supervisor: the person designated to be in charge of crane lifting; this may be the crane operator or an individual whose function it is to supervise lifting operations.

List: the angle of inclination about the longitudinal axis of a vessel.

Live boom: a boom which is lowered by free-fall rather than controlled boom lowering under power.

Load block: an assembly of hook or shackle, swivel, pins, and frame.

Load moment indicator (rated capacity indicator): a device which indicates the bending moment on a crane by measuring both the load on a boom and the horizontal distance from the load (boom point) to the crane's axis of rotation. Load moment indicators are often equipped with warning devices or disengaging devices which are actuated before a crane is overloaded.

Load performance test: a test of a crane's performance, structural competence, and stability while lifting at a percentage of

its rated load capacity.

Locomotive crane: a crane mounted on a base or car equipped for travel on a railroad track.

Long-bed end-dump trailer: a trailer with a length of 9 m (30 ft) or more, a length-to-width ratio of or exceeding 4:1, and which is used to transport and dump material.

Luffing jib crane: a type of jib on a tower crane which is pivoted at the jib foot and supported by luffing cables. The hoist rope usually passes over a sheave at the jib point and the hook radius is changed by luffing, or changing the angle of inclination, of the jib. Rear pivoted luffing jibs are similar but the pivot is towards the rear of the top of the tower rather than at the jib foot.

Mobile crane: a crane mounted on a truck or crawler.

Monorail: a single run of overhead track.

Operational performance test: a test, conducted without a test load, to determine the proper operation of a crane.

Outrigger: extendable or fixed structural members with one end attached to the base of a piece of equipment and the other end resting on floats on the ground: used to distribute loads in supporting equipment.

Outrigger float: the pedestal (or bearing pad) on which an outrigger beam is supported.

Overhead crane: a crane with a single- or multiple-girder movable bridge or fixed hoisting mechanism and traveling on an overhead fixed runway structure.

Performance test: a test to determine the proper operation of a crane and the ability of the crane to safely lift loads within its performance rating. A performance test includes operational

performance tests and load performance tests.

Pillar crane: a fixed crane consisting of a vertical member, held in position at its base to resist overturning moment, and normally with a constant-radius revolving boom supported at the outer end by a tension member.

Portal crane: a crane consisting of a rotating superstructure with operating machinery and boom, all of which is mounted on gantry structure, usually with a portal opening between the gantry columns or legs for traffic to pass through; may be fixed or traveling.

Reconfiguration: the addition or subtraction of boom, jib, counterweight or, for a fixed crane, a change in foundation.

Saddle-jib: a type of jib on a tower crane which is supported by pendants. The jib is horizontal or nearly horizontal, non-luffing, and the load hook is suspended by a trolley which moves along the jib.

Standby crane: a crane which is not in regular service but which is used occasionally or intermittently as required.

Stiffleg derrick: a derrick similar to a guy derrick except that the mast is supported or held in place by two or more stiff members (stifflegs) which are capable of resisting either tensile or compressive forces. Sills are generally provided to connect the lower ends of the stifflegs to the foot of the mast.

Swinger mechanism: the device which rotates a derrick mast.

Swinging (hanging) lead: pile driving leads which are suspended from an extended boom point sheave pin at the top of the boom. The bottom points of the leads are positioned astride the pile location, the hammer is vertically above the top of the pile. Often the bottoms of the leads are pointed and the weight of the pile leads and hammer force the bottom points into the ground,

holding them in position.

Tailing crane lift: a procedure sometimes used in erecting large pressure vessels or structural elements in which one crane (lead crane) lifts the top of the load and a second crane (tail crane), rigged to the bottom of the load, either secures the bottom of the load from movement or assists in the horizontal positioning of the load.

Tandem crane lift: the use of two or more cranes to lift a load.

Top running bridge: a bridge which travels over top of a runway track.

Tower crane: similar to a portal crane but with a tower intervening between the upperstructure and the gantry or other base structure; typically without a portal. To resist overturning moments, the assembly may be ballasted, fixed to a foundation, or a combination of both. The crane may be either fixed or on a traveling base.

Trim: the angle of inclination about the traverse (lateral) axis of a vessel.

Trolley: the unit that travels on bridge rails and supports the load block.

Two-blocking: the condition when the lower load block or hook assembly comes in contact with the upper load block, or when the load block comes in contact with the boom tip.

Underhung crane (hoist): a crane which is suspended from the bottom flange of a runway track or a single track monorail system.

SECTION 17

CONVEYORS

17.A GENERAL

17.A.01 Conveyor systems shall be constructed and installed in accordance with the manufacturer's recommendations.

17.A.02 Inspection, maintenance, and repair.

a. Inspection, maintenance, and repairs shall be performed in accordance with the manufacturer's recommendations by qualified personnel.

b. No maintenance shall be performed when a conveyor is in operation except for the following:

(1) if lubrication is to be done while the conveyor is in motion, lubrication points shall be easily accessible and safe for lubrication: only trained personnel who are aware of the hazards of the conveyor in motion shall be allowed to lubricate a conveyor that is operating; and
(2) when adjustments or maintenance is required while the conveyor is in operation, only trained personnel who are aware of the hazards shall be permitted to make the adjustment or maintenance.

c. Lockout and tagout procedures shall be used. ***> See Section 12***

d. Safe access shall be provided to permit inspection, lubrication, repair, and maintenance activities.

17.A.03 Safety devices.

a. On all conveyors where reversing or runaway are potential hazards or the effects of gravity create a potential for hazardous